Web-based Weight Management Programs in an Integrated Health Care Setting: A Randomized, Controlled Trial

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Abstract

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Objective: To assess the efficacy of a Web-based tailored behavioral weight management program compared with Web-based information-only weight management materials.

Research Methods and Procedures: Participants, 2862 eligible overweight and obese (BMI = 27 to 40 kg/m^2) members from four regions of Kaiser Permanente's integrated health care delivery system, were randomized to receive either a tailored expert system or information-only Web-based weight management materials. Weight change and program satisfaction were assessed by self-report through an Internet-based survey at 3- and 6-month follow-up periods.

Results: Significantly greater weight loss at follow-up was found among participants assigned to the tailored expert system than among those assigned to the information-only condition. Subjects in the tailored expert system lost a mean of 3 ± 0.3% of their baseline weight, whereas subjects in the information-only condition lost a mean of 1.2 ± 0.4% ($p < 0.0004$). Participants were also more likely to report that the tailored expert system was personally relevant, helpful, and easy to understand. Notably, 36% of enrollees were African-American, with enrollment rates higher than the general proportion of African Americans in any of the study regions.

Discussion: The results of this large, randomized control trial show the potential benefit of the Web-based tailored expert system for weight management compared with a Web-based information-only weight management program.

Key words: on-line, health behavior change, expert systems, Internet

Introduction

In 2000, 33% of adults in the United States were overweight, and an additional 31% were obese (1,2). A 1993 survey of the Kaiser Permanente Northern California Region membership found 52% to have a BMI of 25 kg/m^2 or greater (3). Compared with the referent Kaiser Permanente Northern California Region population with a BMI of 20 to 24.9 kg/m^2, health care expenditures were 25% higher in the population with BMI of 30 to 34.9 kg/m^2 and 44% higher in the population with BMI of ≥35 kg/m^2. A RAND study (4) showed that obesity is associated with 36% higher inpatient and outpatient costs and that it has roughly the same association with chronic illness as does 20 years of aging. The prevalence of obesity nationally, combined with ever-increasing pressure to control health care use and costs, make it imperative for health care organizations to implement more effective, efficient, and proactive tools for health behavior change and decision-making.

Web-based weight management programs have the potential to reach millions of individuals at a relatively low cost. Questions remain, however, about the efficacy of such programs in accurately informing the user and facilitating health-related behavior change through evidence-based methods. While a large number of weight management programs are now offered through the Web, most of these

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sites contain information of questionable value (5) and generally fail to take advantage of existing research or established theoretical models (6). In one of the first randomized trials conducted in this area, Womble et al. (7) recently found poor outcomes of a commercial Internet-based diet program (eDiets).

Web-based programs using trained on-line counselors, however, have shown successful weight loss outcomes (8–10). These studies signify the Internet as a viable media channel for weight loss programming. The reach of such programming, however, is limited to the number of available weight management counselors.

One of the advantages of trained counselors is their ability to assess specific needs and interests of the client and tailor feedback in a manner that 1) focuses content to these specific needs and interests, ideally providing just the right help at the right time and 2) removes extraneous content. The content and sequencing of the assessment and feedback by the human counselor are hopefully based on empirically- and theoretically-based understanding of the problem. Software programs attempting to replicate and standardize this interactive assessment and tailored feedback process are termed "expert systems" (11). Digitally tailored print versions of expert systems have been found to be successful in reducing dietary fat intake (12) and in increasing physical activity (13). While digitally tailored print materials can be distributed at a low cost relative to most existing approaches to weight management, the Internet can distribute these materials at a far lower cost. Moreover, the Internet offers significant advantages over print-based tailored materials in the interactivity and vividness of data collection and feedback.

This study examines the outcomes of an Internet-based expert system compared against a user-navigated, information-only program for weight management. Both programs in this trial are completely automated, offering the ability to scale to millions of users at a relatively low cost. These programmatic attributes are critical to large health care organizations interested in population-based disease prevention and management.

Research Methods and Procedures

Recruitment and Sampling

Participants for this study were recruited from four regions of Kaiser Permanente: Georgia, Mid-Atlantic States, Northwest, and Ohio. Kaiser Permanente is a non-profit integrated health care delivery system, serving more than eight million members in eight regions. Members were informed of this study through their clinicians, member newsletters, and flyers, as well as letters to members in Kaiser Permanente diabetes and cardiovascular disease registries. A total of 2862 eligible participants were enrolled over a 6-month period beginning in September 2002; the majority of recruitment occurred within the first 2 months through newsletters and flyers. Eligible participants were current members of Kaiser Permanente ages 18 years and older who had regular access to both the Web and a functioning e-mail address, had a BMI of 27 to 40 kg/m^2, and expressed a willingness to complete follow-up questionnaires. Potential participants were excluded if they had used surgical treatment for weight loss or were currently pregnant or planning pregnancy.

Design

The study protocol was approved by the institutional review boards of each participating Kaiser Permanente region, and on-line informed consent was obtained from all participants. Study participants accessed the study website through a link from within the Kaiser Permanente member website. All users who met eligibility requirements were offered participation in the study. Participants accessed the baseline assessment questionnaire; the responses to these questions were intended to provide baseline data for each participant and were also the basis of the tailoring for the expert system condition. Within 24 hours, all participants were notified by e-mail that they had access to their behavioral support Internet site and resources.

Enrollees were randomly assigned to one of two Web-based treatments for weight management: the expert system materials or information-only materials. Participants were not informed of their treatment assignment. The baseline Web-based assessment was the same for both experimental conditions, collecting data related to demographics; personal and family health history; former weight loss experiences (including former use of specific weight loss treatments and outcomes from weight loss attempts); general self-care activities (including tobacco, physical examinations, flossing, seat belt use, and stress management); physical activity, ability to be physically active, and barriers to being physically active; perceived difficulty in controlling diet and physical activity; worry regarding body image; barriers to weight management; psychosocial stress and coping; general dietary preferences (e.g., consumption of alcoholic beverages, desserts, fast food, high-fat dairy products, fried food); foods typically consumed when stressed; weight loss goals and motivation to lose weight; source of motivation (e.g., personal choice, pressure from others); a typological assessment of eating behavior (e.g., whether the subject eats in response to certain emotions, restricts food intake, then eats because of hunger, etc.); attitudes regarding overweight individuals (e.g., that they lack willpower, are unattractive, cannot be physically fit, etc.); weight-related self-efficacy; weight loss expectations (e.g., looking and feeling younger, reducing risk of disease, having clothes fit better, reassuring others, getting people to stop nagging them to lose weight, etc.); and perceived social support. Most participants were able to complete the baseline assess-

ment in ~15 to 20 minutes. Participants in both conditions were able to review answers before submitting their information.

Treatment Conditions

Tailored Expert System Condition. The tailored expert system (TES)[1] condition used Balance, a 6-week self-help weight management program developed by HealthMedia, Inc. Using a software algorithm that uses the baseline assessment data and connections between data elements, the Balance program creates an individually tailored weight management plan. The Balance program does not use a specific diet per se (e.g., Atkins), focusing instead on a healthy diet, behavioral and social cues to eating, physical activity, better understanding of the relationship between food consumption and energy expenditure, calorie and fat consumption, attributions for previous weight management efforts, body image, and social support. For example, participants reporting a family history of a particular disease received information regarding the connection of obesity to this class of diseases; participants who reported greater ability to change diet than physical activity received more dietary advice; specifically cited barriers and lack of efficacy were addressed with messages tailored to those issues; psychosocial stress was compared with reported coping abilities and accompanied with tailored stress management advice; and participants who reported that overweight individuals lacked willpower were given messages attempting to change this perception to a more controllable, external attribution (14,15). Participants were also offered the opportunity to enroll a supportive "buddy." Buddies were sent e-mail messages regarding the user's efforts to manage their weight and encouraged to provide informal support. Participants who reported an inability to exercise were not provided exercise advice.

The TES Web-based materials consisted of an initial guide followed by tailored action plans delivered at 1, 3, and 6 weeks into the program. An e-mail sent to the participants informed them of the availability of the follow-up tailored action plans. Follow-up materials were designed to reinforce dietary and physical activity improvements, address specific barriers, and provide support and self-monitoring resources. Participants were allowed to return to any of the materials throughout the course of the study.

Information-only Condition. The information-only (IO) condition was part of the standard Kaiser Permanente member website available to all Kaiser Permanente members at the time of the study. The program included an overview and sections related to the importance of weight and weight management; definitions of a healthy weight; determinations of whether the participant is overweight; preparation for weight management; facts about weight loss diets and programs; and weight management strategies. The information of the Kaiser Permanente member website was carefully reviewed before its inclusion and was considered accurate, timely, comprehensive, and relevant to the needs of Kaiser Permanente members. Through a menu, the user had the option of selecting any section for viewing and reviewing. They could also view other health topics on the site, such as diabetes or asthma, of their choosing. Using this program, participants were able to create their own educational experience. As in the TES condition, participants were allowed to return to the site throughout the course of the study.

Measures and Follow-up Procedures

Baseline and 3- and 6-month data were collected by self-report using Web-based questionnaires. Participants were notified by e-mail of the availability of each follow-up questionnaire. Participants received up to 21 e-mail reminders over a 3-week period before being considered a non-respondent to the follow-up assessment. All participants originally enrolled at baseline were sent e-mail prompts to complete the follow-up surveys, regardless of response status at prior follow-up assessments.

Primary Outcome. The primary outcome was percentage of baseline weight lost, calculated by subtracting weight at each follow-up from weight at baseline and dividing by baseline weight.

Process Measures. In addition to the primary outcome, process measures were collected at each follow-up, including whether the user read the information completely, found the information helpful, easy to understand, and personally relevant, and whether they would recommend the program to others.

Non-respondent Survey

To examine possible biases as a result of low follow-up response rates, a small telephone survey of a random sample of 70 non-respondents to the Web-based 6-month follow-up survey was conducted. The survey determined self-reported weight. Responses from this sample of non-respondents were compared with the 6-month data of respondents.

Statistical Analyses

Primary analyses focused on relative weight loss between the two intervention conditions. Percent changes in weight from baseline at 3- and 6-month follow-ups were analyzed using repeated-measures ANOVA. Two methods of missing data treatment were applied to these analyses: 1) a completers-only analysis examining those who completed both 3- and 6-month follow-up surveys and 2) a last-observation-carried-forward (LOCF) analysis including all study participants, with imputation of missing data using most recently collected weight measures. χ^2 tests were used to

[1] Nonstandard abbreviations: TES, tailored expert system; IO, information-only; LOCF, last-observation-carried-forward.

Table 1. Participant characteristics at baseline stratified by treatment condition*

	TES (n = 1475)	IO (n = 1387)
Age (years)	45.6 (12.1)	45.2 (12.0)
Sex (% female)	82.9%	82.7%
Race-ethnicity (%)		
African-American	35.4%	35.8%
Hispanic	3.4%	3.1%
White	56.8%	56.3%
Other	4.4%	4.8%
Motivation (0 to 10)	7.2 (2.0)	7.3 (2.1)
Self-efficacy (1 to 5)	2.5 (0.8)	2.5 (0.8)
Weight (kg)	92.2 (14.4)	92.5 (14.3)
BMI (kg/m^2)	33.0 (3.8)	31.1 (3.9)

TES, tailored expert system; IO, information-only.
* There were no statistically significant differences between the two treatment conditions.

examine differences in process measures between the two treatment conditions. Statistical analyses were conducted using the Statistical Package for the Social Sciences (version 11.5, SPSS, Chicago, IL).

Results

Baseline Characteristics and Attrition

Table 1 presents characteristics of participants at enrollment for both treatment conditions. There were no significant differences between the two conditions with respect to self-reported sex, race/ethnicity, motivation to manage weight, self-efficacy, initial weight, or BMI. The proportion of women relative to men enrolling in the program was very high (83%). The number of African Americans enrolling in the program (36%) was higher than the proportion of African-Americans members in any of the Kaiser Permanente regions.

Response to the 3- and 6-month Surveys. A total of 867 (30% of participants enrolled at baseline) participants responded to the Web-based 3-month follow-up survey. There was no significant difference in response rates to the 3-month follow-up survey between the two treatment groups. A total of 585 (20% of participants enrolled at baseline) participants responded to the 6-month survey: 494 3-month respondents and 91 3-month non-respondents. As in the 3-month survey, there was no significant difference in 6-month follow-up response rate between the two treatment groups. There was no difference in BMI or sex between respondents and non-respondents. There was also no difference in 6-month response rates between men and women. Race-ethnicity was significantly associated with the likelihood of response: whites were most likely to respond (24%) compared with African Americans (16%) and Hispanics (19%). There was also a significant difference in response rates by age, with higher response rates among those ≥55 years of age (25%) compared with those 35 to 54 (20%) and 18 to 34 (16%) years of age.

Table 2. Weight characteristics of survey respondents and a non-respondent sample at 6-month follow-up

	Respondents (n = 585)	Non-respondent sample (n = 27)	p
Six-month weight (kg)	91.3 ± 0.6	87.7 ± 3.0	NS
Six-month % weight loss	2.0 ± 0.3	3.1 ± 1.2	NS
Six-month average weight loss (kg)	2.1 ± 0.3	3.5 ± 1.2	NS

Values are means ± standard error. NS, not significant.

Non-respondent Survey Results. To determine whether significant biases existed as a result of the relatively low response rate to the Web-based 6-month survey, we conducted a telephone survey of a sample of non-respondents. Of 70 non-respondents called, 29 (41%) were reached and were asked about their current weight. Two of these 29 subjects refused to provide weight information, leaving 27 non-respondents who provided weight information. No significant differences were found between 6-month respondents and the 6-month non-respondent sample in 6-month weight or weight loss (Table 2). Of the 27 interviewed, 11 (41%) reported not receiving any e-mail notification of either the 3- or 6-month follow-up surveys.

Weight Change

Analysis using repeated-measures ANOVA found a significant effect of the TES condition compared with the IO condition on percentage of weight loss over 3- and 6-month follow-up periods ($F = 7.0$; $p < 0.001$; Figure 1). Significant differences in percentage weight loss and amount of weight loss between the TES and IO conditions were also found at both individual 3- and 6-month follow-up periods (Table 3). Analyses reported are for completers of the 3- and/or 6-month follow-up assessments. Statistically significant differences between TES and IO conditions were also found using LOCF treatment of missing data. LOCF analysis carries forward the last known value for 3- and 6-month non-respondents; for those who did not respond to either

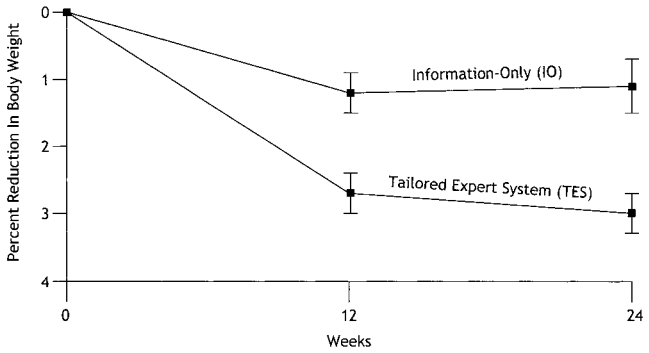

Figure 1: Mean percentage reduction in initial weight for participants assigned to the TES vs. an IO site in an analysis in which missing values were excluded.

follow-up assessment, their baseline weight would be used (i.e., imputation of no weight change). Repeated-measures ANOVA found a significant difference between TES and IO conditions ($F = 9.1$; $p < 0.0001$). Because of the high rate of missing data at both 3- and 6-month assessments, LOCF analyses would generate a low estimate of weight loss. At 3-month follow-up, the average percentage weight loss using an LOCF analysis was 0.8 ± 0.1% among participants in the TES condition compared with 0.4 ± 0.1% among participants in the IO condition ($F = 12.2$; $p < 0.0005$). At 6-month follow-up, the percentage weight loss using an LOCF analysis was 0.9 ± 0.1% in the TES condition compared with 0.4 ± 0.1% in the IO condition ($F = 15.9$; $p < 0.0001$).

A greater proportion of participants in the TES reported having read the weight management information than participants in the information-only group (Table 4). Participants in the TES group were also more likely to report that their Web-based materials were helpful, easy to understand, and personally relevant. Finally, more TES participants reported that they would be likely to recommend the program to others than IO participants.

Table 4. Program response at 6 months by treatment condition

	TES ($n = 306$)	IO ($n = 279$)	p
Read information completely (% positive)	82.1%	67.0%	0.0001
Materials were helpful (% positive)	74.6%	56.7%	0.0001
Information was easy to understand (% positive)	92.8%	81.6%	0.0001
Materials were personally relevant (% positive)	78.0%	60.8%	0.0001
Would recommend program to others (% positive)	74.9%	58.7%	0.0001

TES, tailored expert system; IO, information-only.

Discussion

This study found that overweight and obese members of a large managed care system who were assigned to a Web-based TES for weight management reported significantly higher weight loss at 3- and 6-month follow-up than those assigned to a Web-based weight management IO condition. In addition, participants assigned to the TES were far more likely to have read the Web-based information completely and to have found the materials helpful, easy to understand, and relevant.

Of particular note is the high rate of enrollment (36% of study participants) by African-American members of Kaiser Permanente. The enrollment rate of African Americans in this study was higher than the general proportion of African Americans within each Kaiser Permanente region of the study. Tailoring specific Web-based weight management programming for African Americans may be an interesting direction for further research and real-world intervention.

Table 3. Weight loss by treatment condition

	TES	IO	p
Three-month weight outcomes	$n = 438$	$n = 429$	
Percent weight loss ± SE	2.7 ± 0.3%	1.2 ± 0.3%	0.0001
Weight loss (kg) ± SE	2.6 ± 0.3	1.2 ± 0.3	0.0007
Six-month weight outcomes	$n = 306$	$n = 279$	
Percent weight loss ± SE	3.0 ± 0.3%	1.2 ± 0.4%	0.0004
Weight loss (kg) ± SE	2.8 ± 0.3	1.1 ± 0.4	0.0007

TES, tailored expert system; IO, information-only; SE, standard error.

The primary strengths of this study include the large and diverse sample and the testing of a completely automated Web-based intervention. Such programs, once built, can reach millions of individuals who participate autonomously and privately. Automated Web-based weight management programming allows organizations to scale the reach of the program while maintaining a consistent standard of quality. Another important strength of TESs is the collection of assessment data. These data allow ongoing analyses to improve the program through a better understanding of the population using the program and particular subgroups for whom the program is working or not.

Limitations of the study include the reliance on self-reported data and a high rate of non-response to the follow-up assessments. With respect to reliance on self-reported data, this study could not verify claims of weight reduction through individual clinical assessment because of the geographic spread of the sample. Whereas individuals tend to over-report height and under-report weight, we know of no data from weight management studies (clinical or population-based) showing a differential reporting bias by experimental condition. Because the two interventions in this study included the same assessment and follow-up procedures and a similar Web-based interface, we believe that differential reporting bias by intervention group would be minimal.

The high rate of non-response to the follow-up assessments is a significant limitation of the study. Response to Web-based surveys has generally been similar to response found from mailed surveys (16,17); however, our response rates to these surveys were lower than those found in other weight management studies. Response rates to both 3- and 6-month follow-up surveys, however, did not significantly differ between the two experimental groups. Moreover, there was no difference in baseline BMI between follow-up survey respondents and non-respondents. This issue was also studied through a non-respondent survey, which found no difference in weight loss between respondents and non-respondents. We, therefore, believe that the differences found between the two groups of respondents are not likely to be the result of selection or other biases.

An important finding from our non-respondent survey is that more than two-fifths of the non-respondent sample indicated that they had never received e-mail notification of an assessment survey. While participants may have never noticed the e-mail notification or may have forgotten having received the notification, it is also possible that "spam" filtering or e-mail address changes could have limited actual e-mail notification. Further research examining specific reasons for Web-based survey non-response is needed. Moreover, given the generally low rate of response to follow-up surveys on the Web, we suggest that future studies of a similar nature consider non-response surveys as a part of data collection activities.

Both the Web-based interventions and the methods for evaluating these interventions are quite new to the weight management field. Future research should further explore the active elements of Web-based weight management programs and their use in a variety of settings and populations. Methodological research should explore the validity and possible biases of Web-based surveys. Scholarly interactions between weight management and interactive health communications experts should yield important new approaches to more effective, higher reaching, and lower cost weight management programming.

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